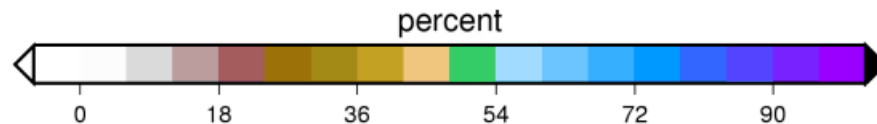
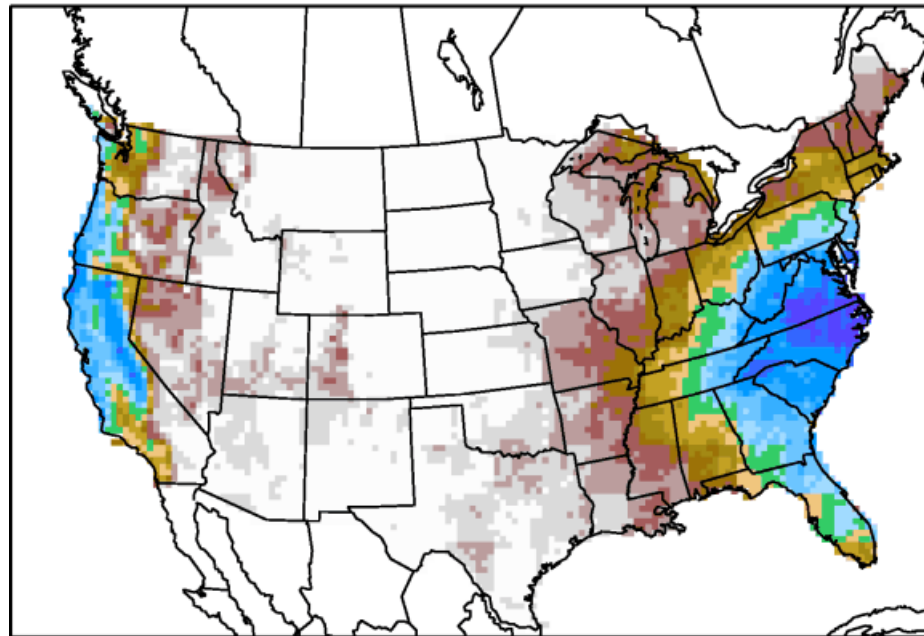


New Experimental PQPF Products from CDC

Jeff Whitaker, Tom Hamill and Xue Wei
NOAA Climate Diagnostics Center, Boulder
jeffrey.s.whitaker@noaa.gov

Analog Prob Precip > 2.5mm
fcst from 2005022500 valid 2005022800-2005022800 percent

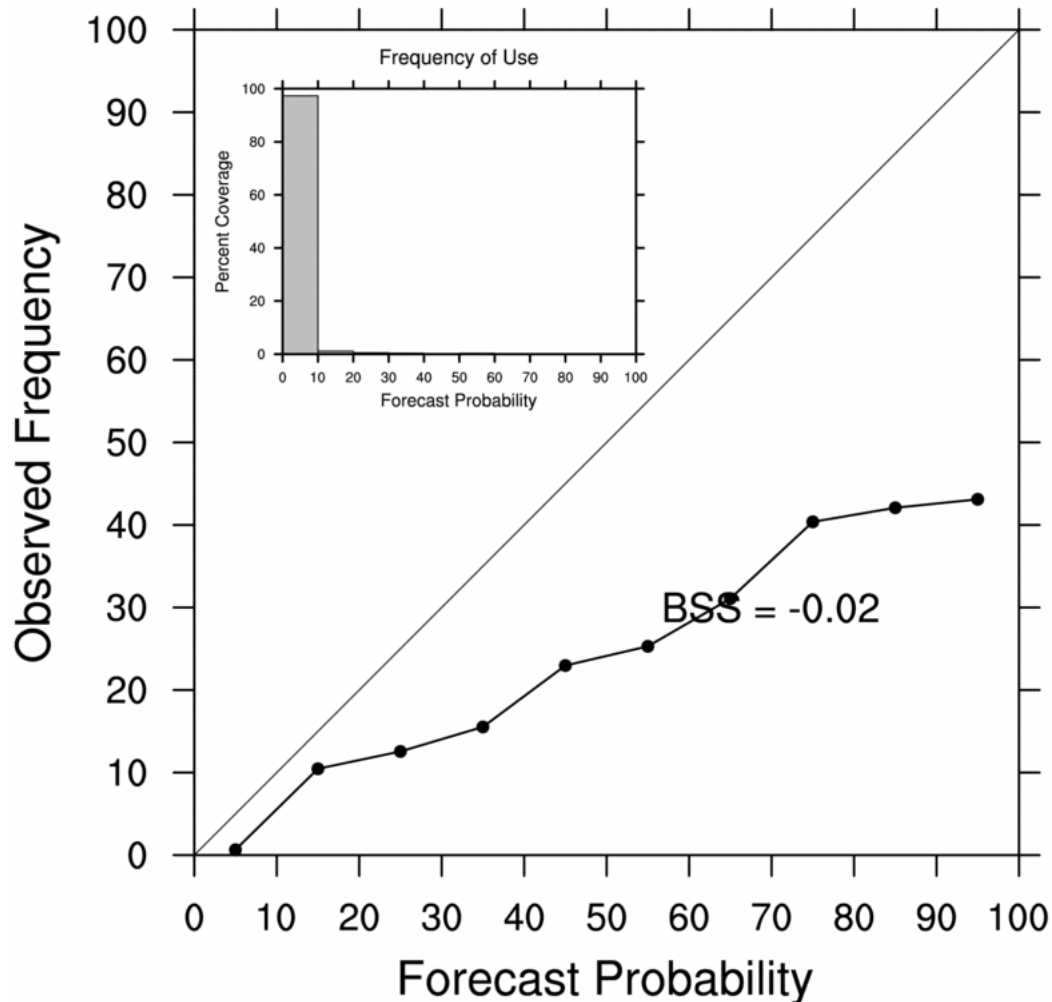


Why PQPF is hard

- Large model systematic errors (in mean and shape of probability distribution - e.g. the drizzle problem).
- Lots of spatial detail not resolved by models.
- Raw probabilities from ensembles have low skill.

Skill of GFS EPS (JFM 2002/2003)

Day 3 P > 25 mm CONUS



What do we want?

- PQPF is a conditional probability - the probability distribution for observed weather given a forecast from a model.
- Using ensemble relative frequencies assumes that the forecast PDF is the same as the conditional probability of observed weather (model is perfect).

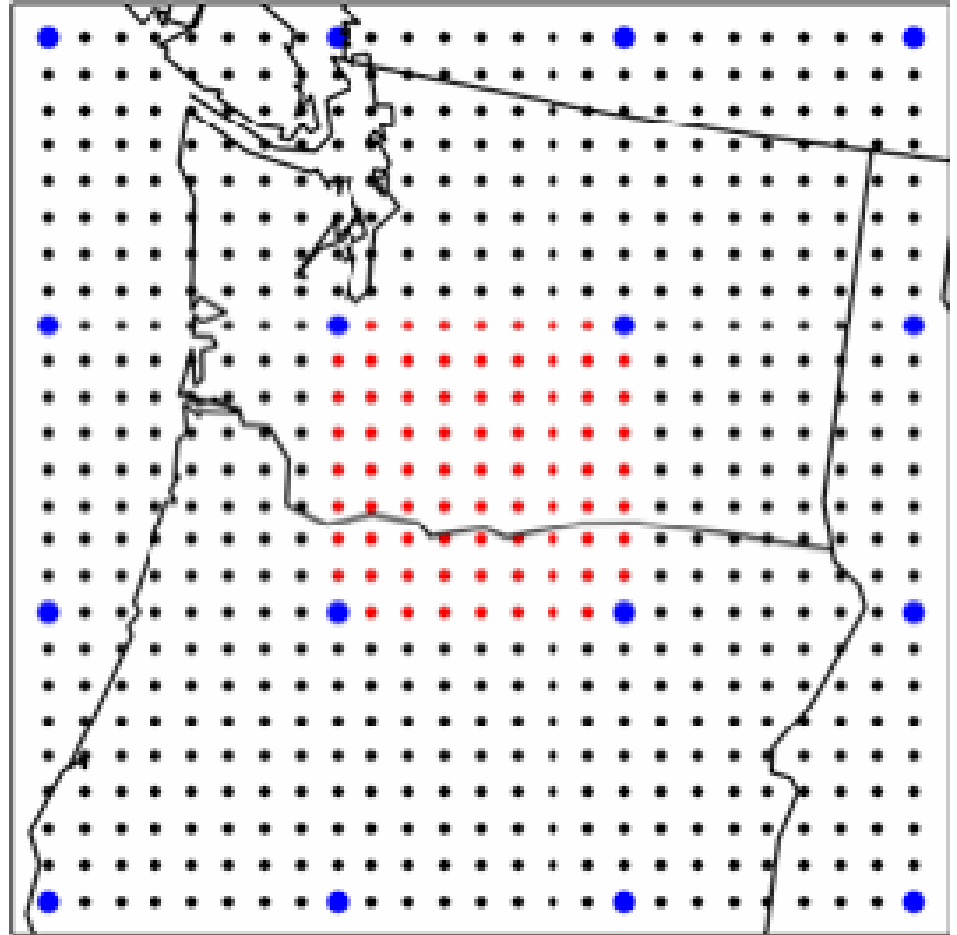
How do we get it?

Conditional climatology of observed wx given a model forecast.

- **Forecast Analogs:** Given today's forecast, find prior cases when forecast was close to it, use corresponding analyses of observed weather.
- **Problem:** Need to wait a REALLY long time to find good analogs! (Lorenz, van den Dool).
- **Solution:** Search for analogs over a limited region.

How analog ensemble is created

- analogs are found in for global model forecasts at blue points
- high-resolution NARR precip for those dates at red points make up analog forecast ensemble.
- process is repeated for next overlapping 16x16 box, forecasts are stitched together



CDC MRF reforecast data set

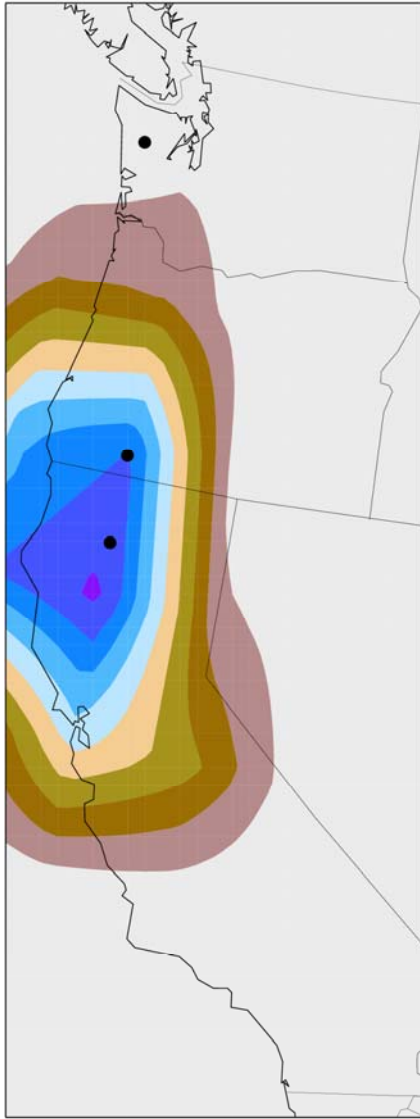
- **Definition of “reforecast”** : a data set of retrospective numerical forecasts [using the same model](#) to generate real-time forecasts.
- **Model**: T62L28 NCEP MRF, circa 1998
(<http://www.cdc.noaa.gov/people/jeffrey.s.whitaker/refcst> for details).
- **Initial states**: NCEP-NCAR reanalysis plus 7 +/- bred modes (Toth and Kalnay 1993).
- **Duration**: 15-day runs every day at 00Z from 19781101 to now.
(<http://www.cdc.noaa.gov/people/jeffrey.s.whitaker/refcst/week2>).
- **Data**: Selected fields (winds, geo ht, temp on 5 press levels, and precip, t2m, u10m, v10m, pwat, prmsl, rh700). (Web form to download at <http://www.cdc.noaa.gov/reforecast>).
- **Verifications**: North American Regional Reanalysis (NARR) - 32km grid.

Positives/Negatives

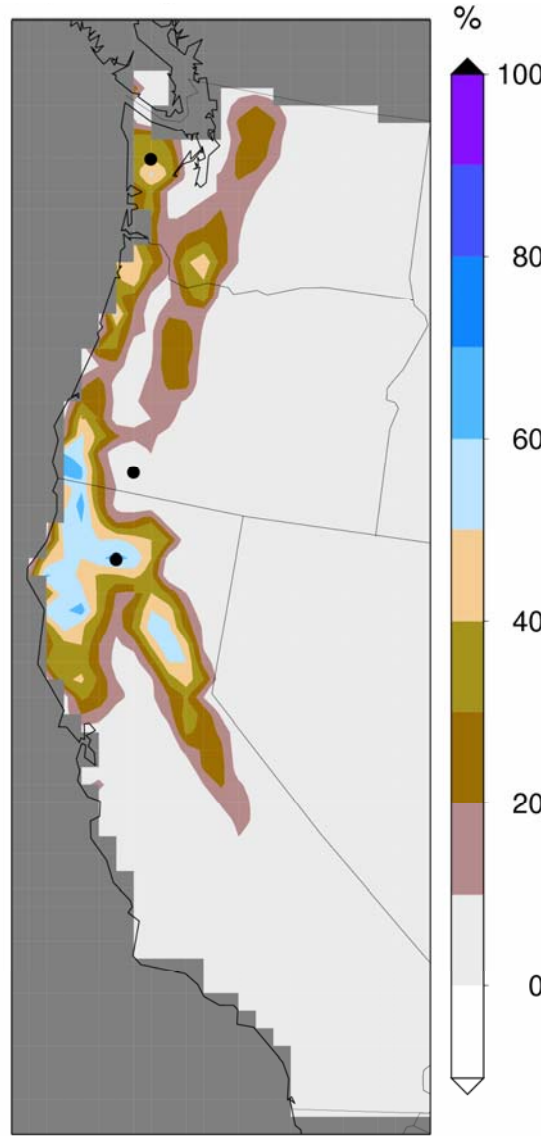
- (+) If you have LOTS of data, can't do any better (no approximation).
- (+) Non-parametric, can be applied to any quantity as long as obs are available.
- (-) Need LOTS of data to find good analogs (decades, not centuries for local analogs).
- (-) Can't handle unprecedented events.

Example: $P > 100\text{mm}$, days 4-6 (19961229-19970101)

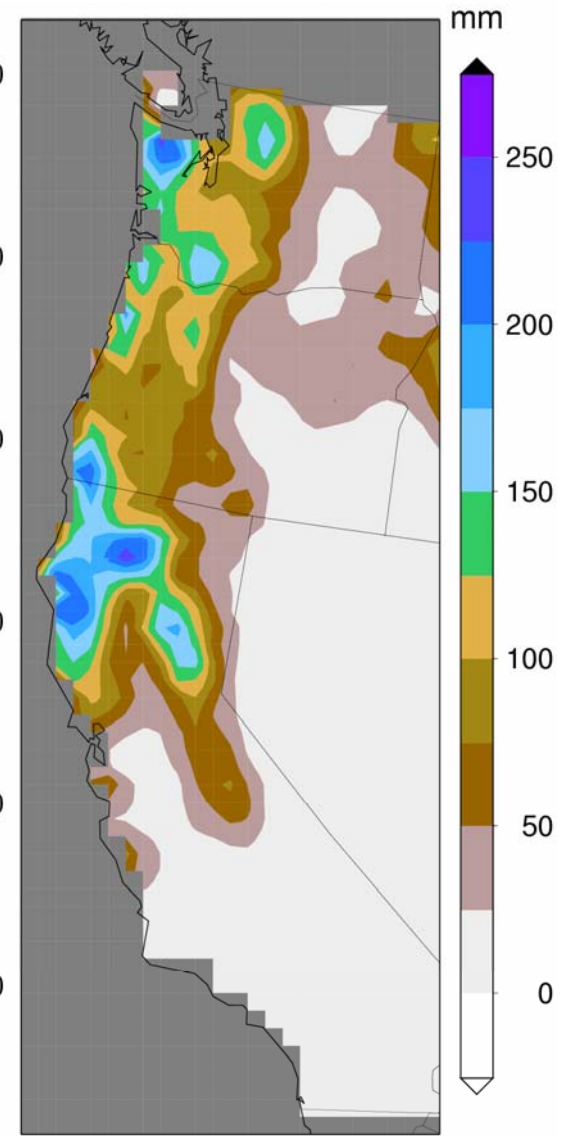
T62 ensemble



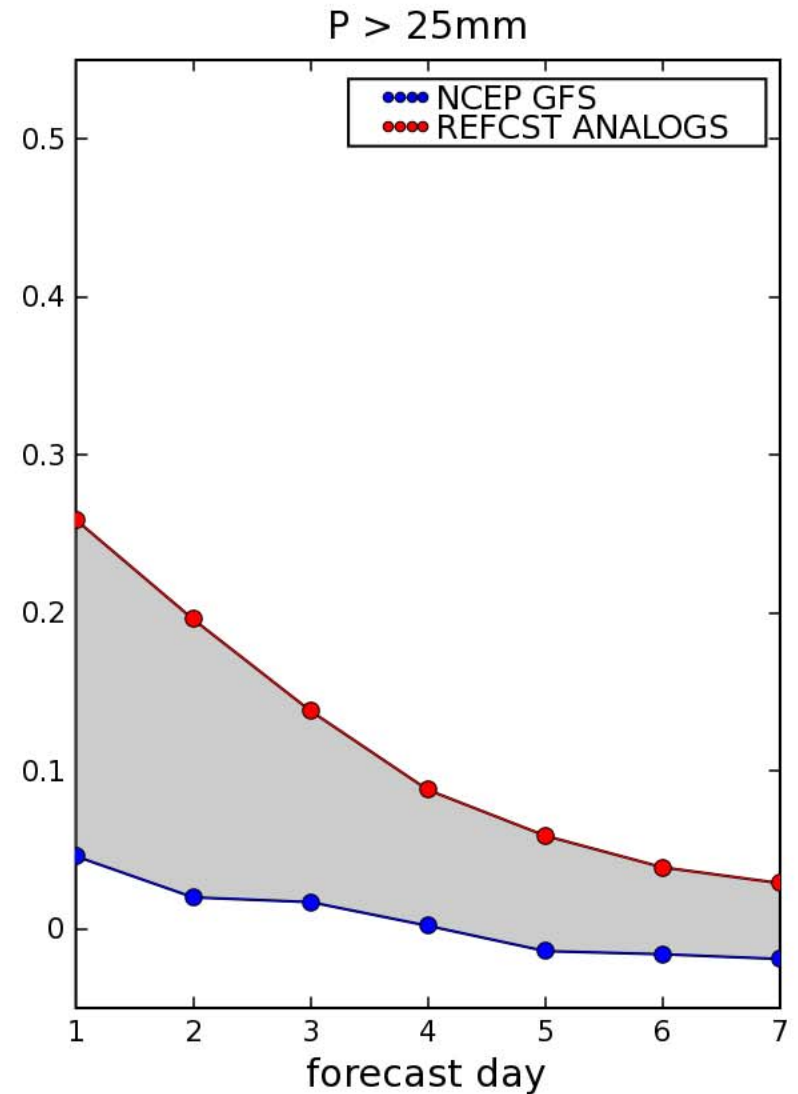
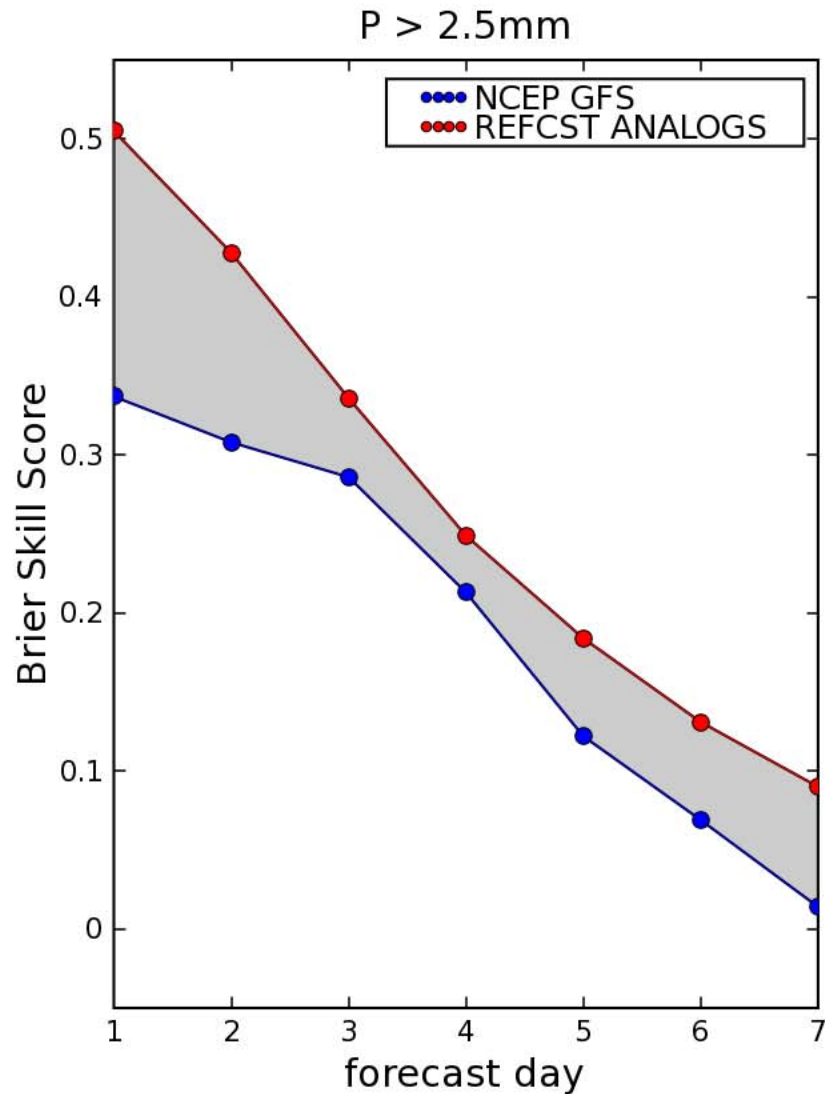
Analog ensemble



NARR analysis

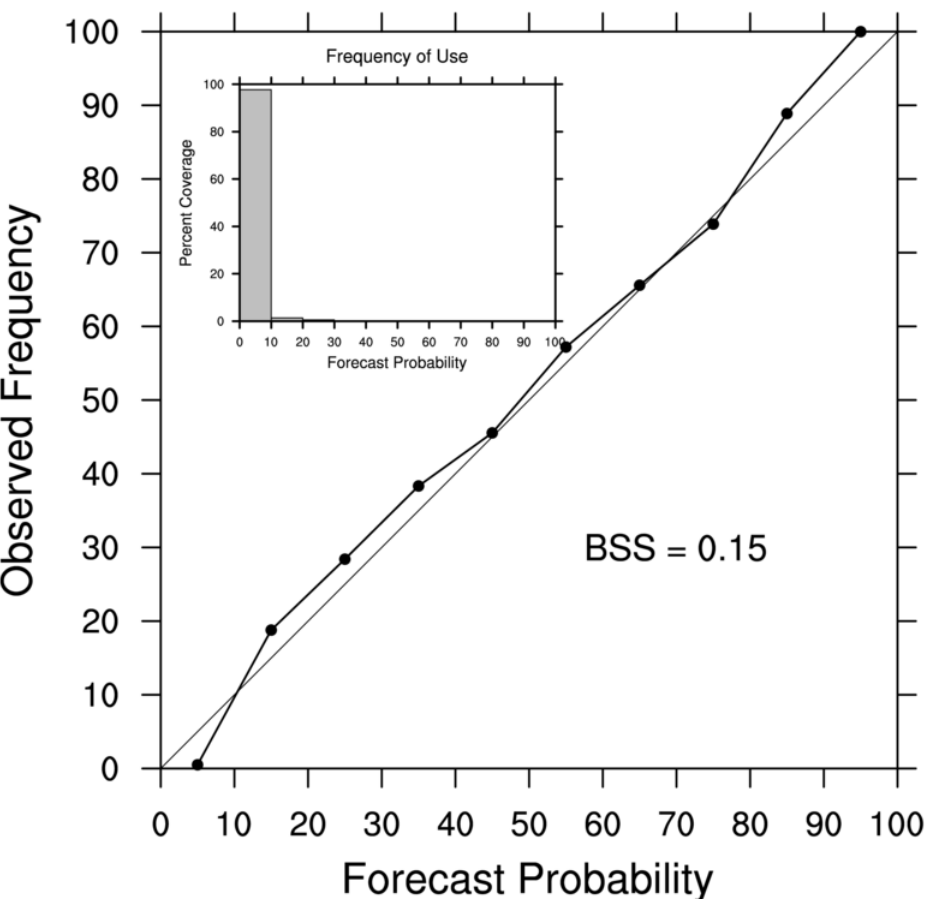


Skill comparison

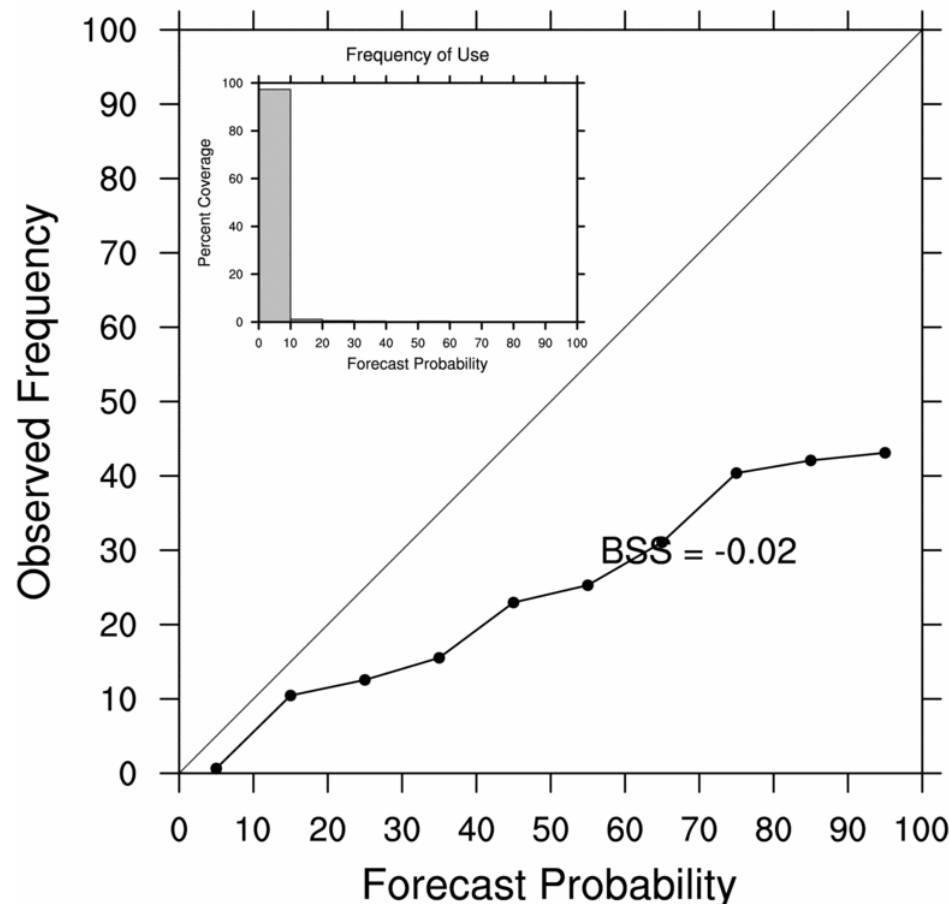


Day 3 P > 25mm, JFM 2002/2003

Reforecast Analogs



Operational GFS

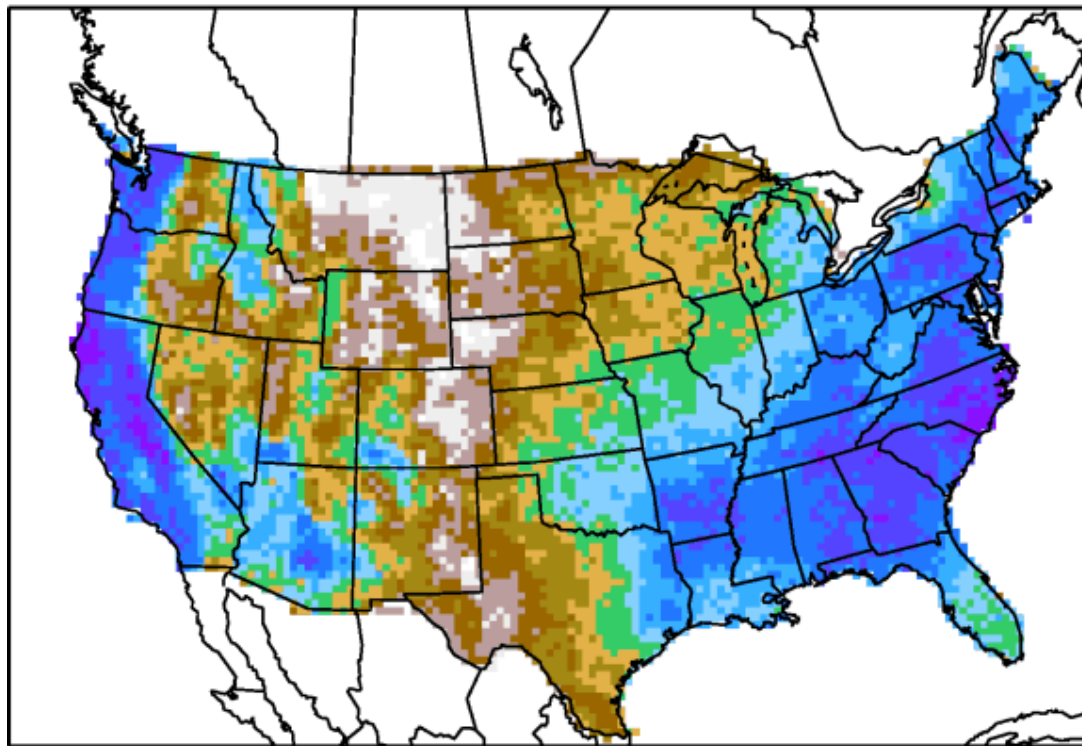


Annual Cycle of Skill

jan Analog Precip Fcst BSS (1979-2003)

Analog Prob Precip > 2.5mm

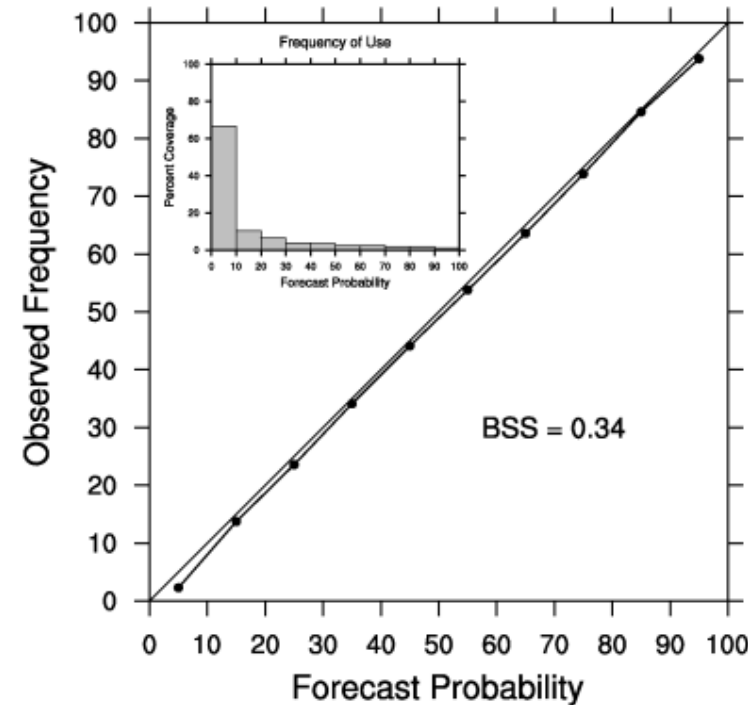
Day 3



Brier Skill Score



jan Analog Prob Precip > 2.5mm Day 3



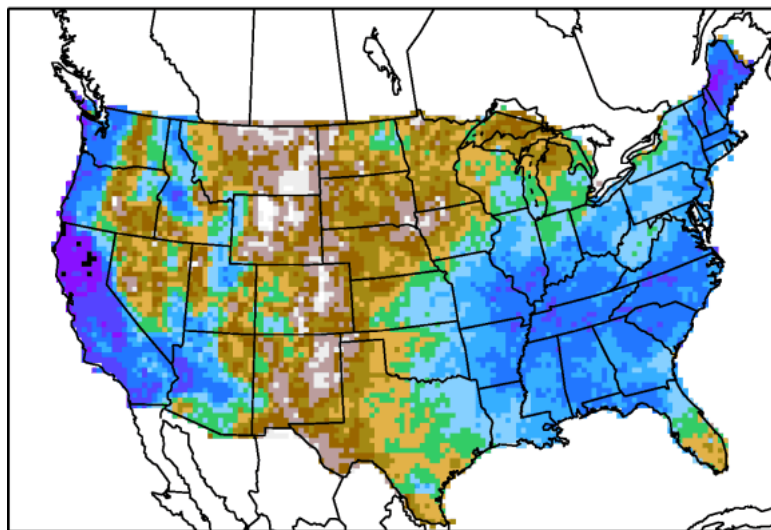
Conclusions

- Big improvement in PQPF skill possible.
- Need long training dataset, especially for high amounts (rare events).
- Need good, long-term obs! (analog PQPF cannot be trusted where NARR precip is suspect).

feb Analog Precip Fcst BSS (1979-2003)

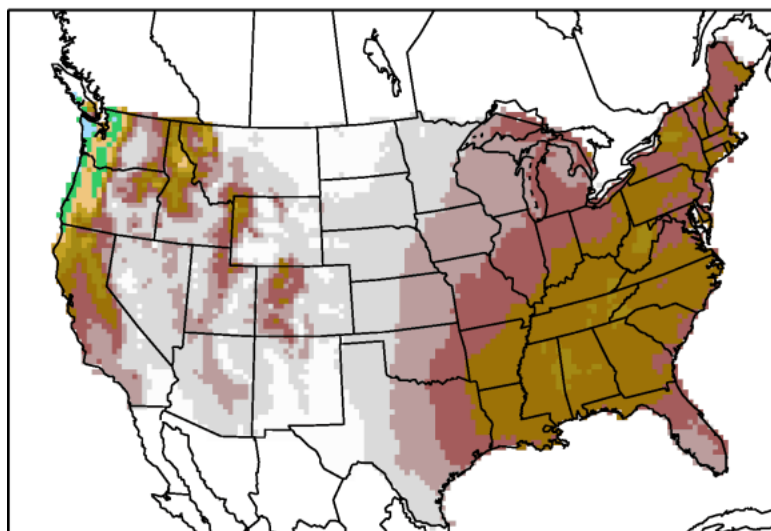
Analog Prob Precip > 2.5mm

Day 3



Climo Prob Precip > 2.5mm

fcst from 2005022800 valid 2005030200-2005030200



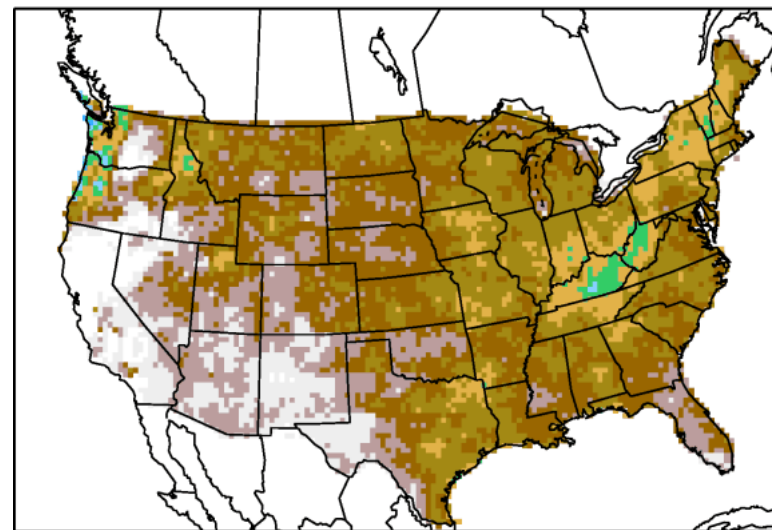
percent



jul Analog Precip Fcst BSS (1979-2003)

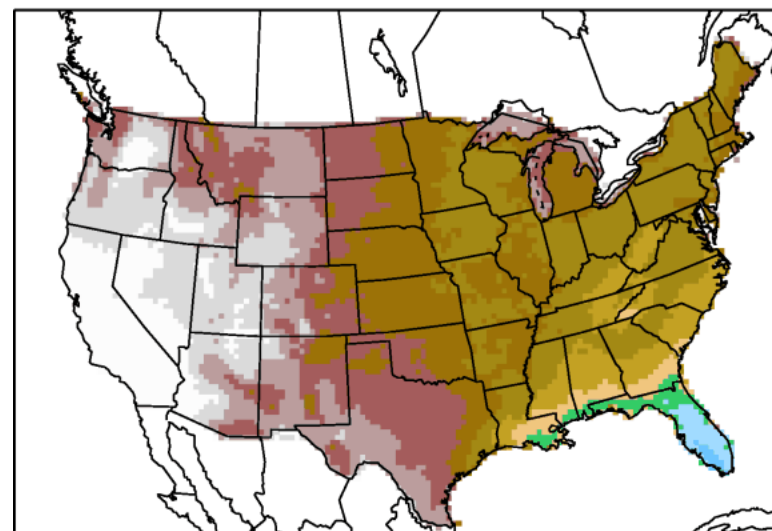
Analog Prob Precip > 2.5mm

Day 3



Climo Prob Precip > 2.5mm

fcst from 2004070100 valid 2004070300-2004070300



percent



Analog technique:

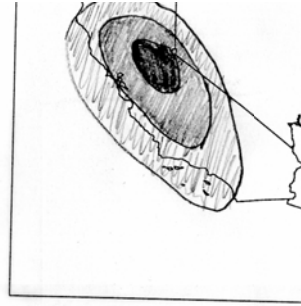
(pioneered by van den Dool, Toth, von Storch, others)

TODAY'S MODEL
PRECIP
FORECAST □ □

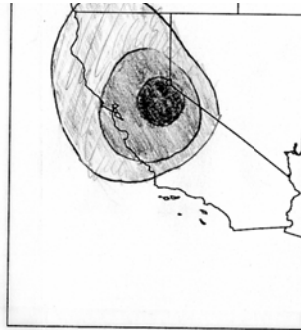
Step 1:
make today's
forecast

Step 2: find dates
of old analogs

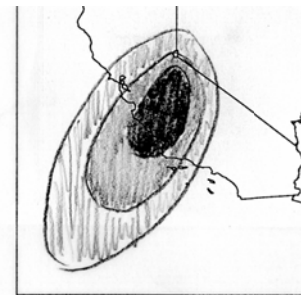
Forecast analog 1,
2/12/95



Forecast analog 2,
1/16/98

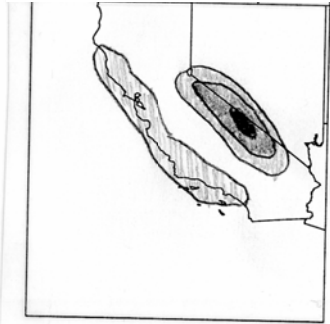


Forecast Analog 3,
3/1/83

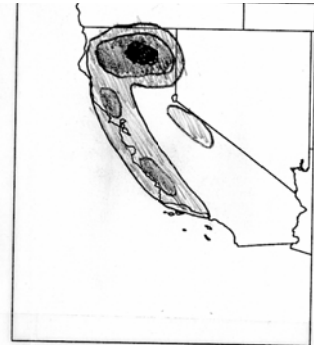


Step 3: extract
observed weather

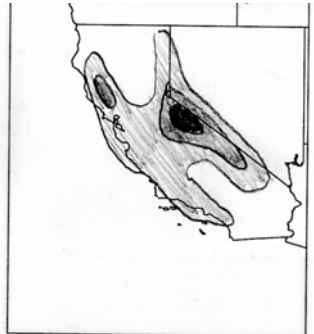
Observed Wx, 2/12/95



Observed Wx, 1/16/98



Observed Wx, 3/1/83

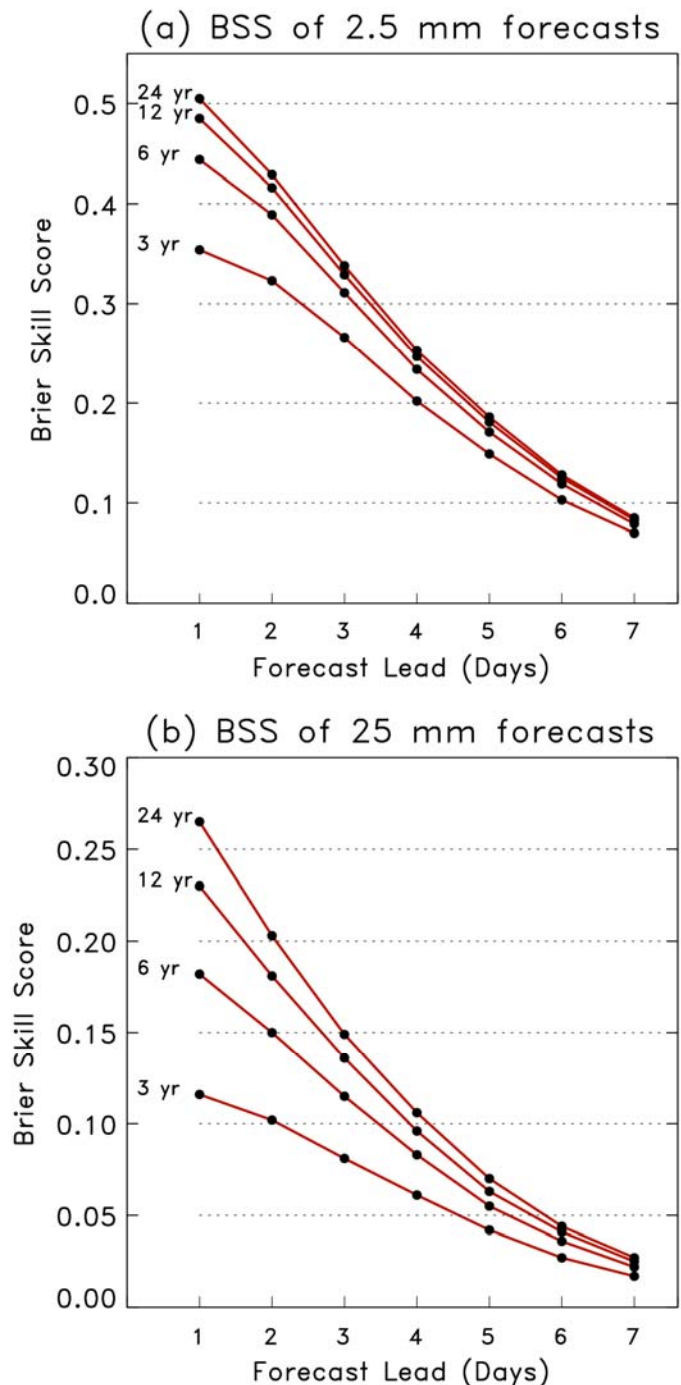


Importance of training sample size ☐

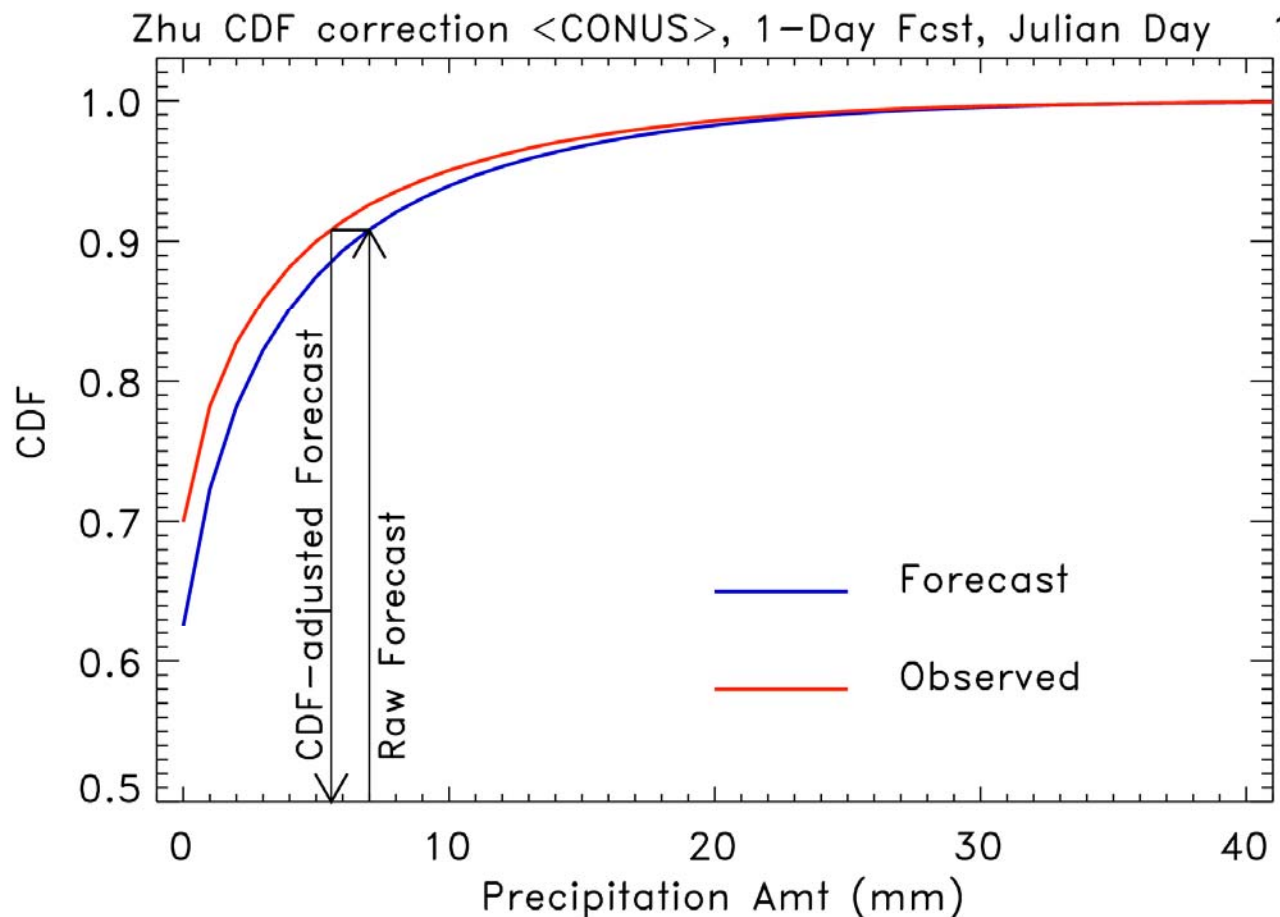
This shows skill of precipitation forecasts the analog technique, JFM 1979-2003 data over conterminous US (CONUS).



increased sample size especially important for calibrating rarer, high-precipitation events.



Other calibration methods: NCEP technique for CDF correction (Yuejian Zhu)

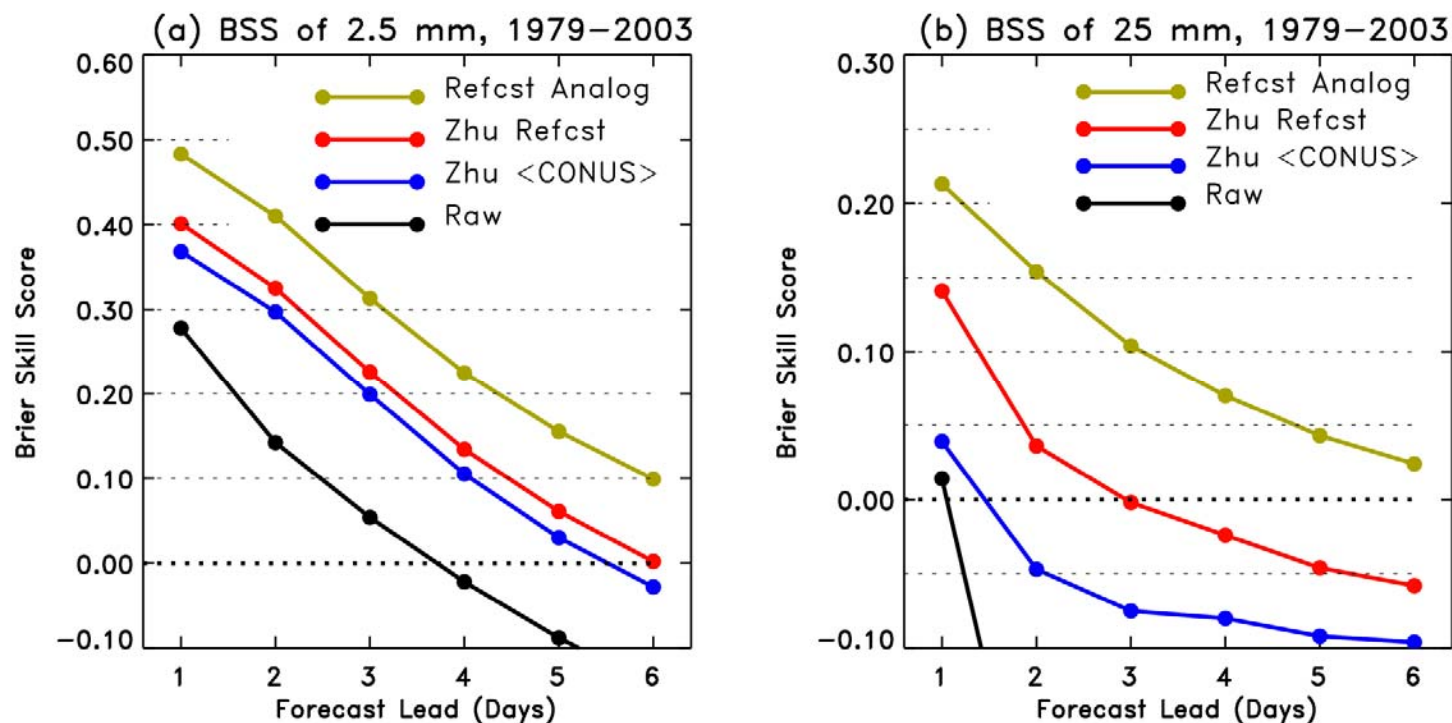


(1) Get CDFs of forecast and observed, averaged over CONUS using, say, last 30 days of data.

(2) Use difference in CDFs to correct each ensemble member's forecast. In example shown, raw 7 mm forecast corrected to ~5.6 mm forecast.

NOTE: bias only, not spread correction.

Skill of CDF correction vs analogs



- Notes:
- (1) Here, verification on coarse 2.5 degree grid.
 - (2) Zhu <CONUS> has benefit at 2.5 mm, correcting drizzle over-forecast.
 - (3) Location-dependent Zhu technique using reforecasts adds skill, esp. at 25 mm.
 - (4) Large additional skill by using analog reforecast technique, again largest at high thresholds.
 - (5) The type of calibration technique really matters.

<http://www.cdc.noaa.gov/reforecast/narr>

Analog forecasts

Back Forward Reload Stop

http://www.cdc.noaa.gov/reforecast/narr

Google

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Jump to: Map Room Weather Products Search for: Go!

You are at: [CDC Home](#) > Analog forecasts

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NOTE: The CDC Web site and data archives may be unavailable from 1300 to 1330 MST (GST-0700) on Thursday, February 24, 2005 due to routine maintenance.

Analog probability forecasts

Many forecast users desire reliable, skillful high-resolution ensemble predictions, perhaps for such applications as probabilistic quantitative precipitation forecasting or hydrologic applications. Our [reforecast dataset](#) is comparatively low resolution (T62, or about 250 km). However, by downscaling the forecasts through analog techniques a high-resolution probabilistic forecast can be produced. The basic idea is this: if we have a long time series of high-resolution analyses, then we can examine today ensemble forecast, look back to our reforecasts and find days in the past where the old forecasts were similar to the current forecast, and note the analyzed conditions associated with those forecasts. With knowledge of the dates of the similar forecasts, we can collect an ensemble of high-resolution analyzed conditions. This technique is appealing, for it simulates the forecast process of many humans: we look at the current forecast, recall situations where the forecast depiction was comparable, and try to recall the weather that actually occurred. The precipitation analyses used for this procedure are the 32-km grids from [the North American Regional Reanalysis](#).

Analysis date: (format: *yyyymmdd*)
Please input a date within last 90 days:

Forecast day from Analysis date:

Threshold

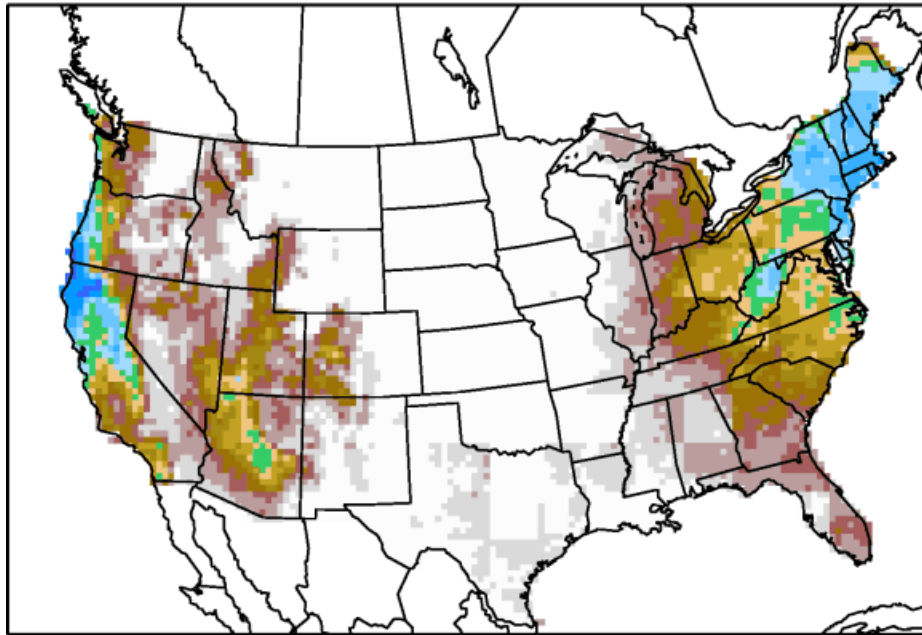
Above or Below

Document: Done

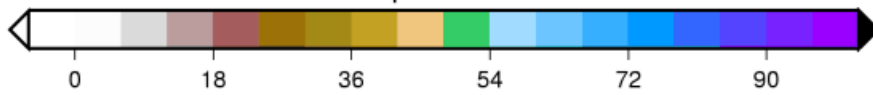
Example - fcst valid yesterday

Analog Prob Precip > 2.5mm

fcst from 2005022600 valid 2005030100-2005030100 percent

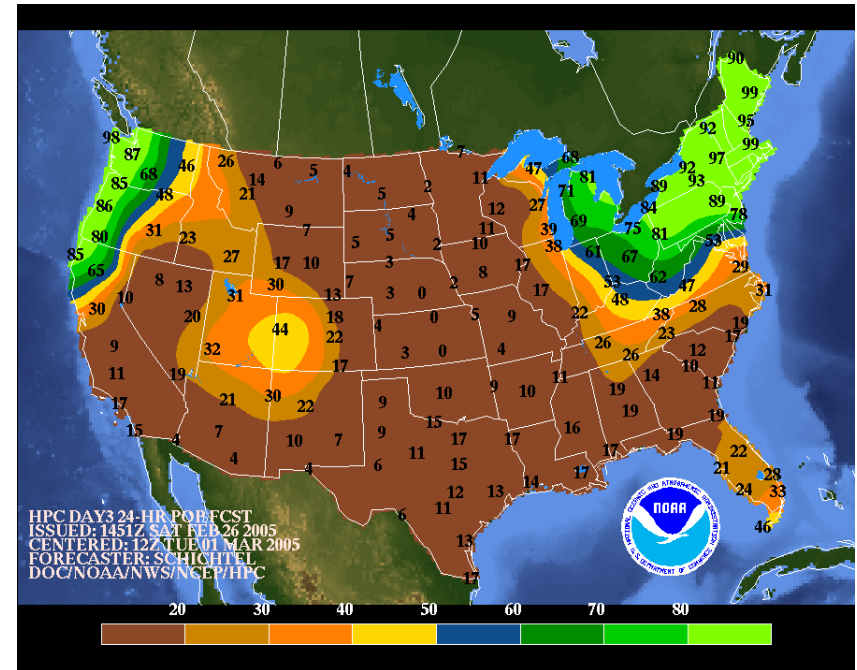


percent



GMT 2005 Feb 26 07:39:07 NOAA Climate Diagnostics Center

HPC 3 day POP



HPC vs REFCST POP verifications (Brier Score)

bars show HPC (days 5-7), red # shows REFCST day 5 score

